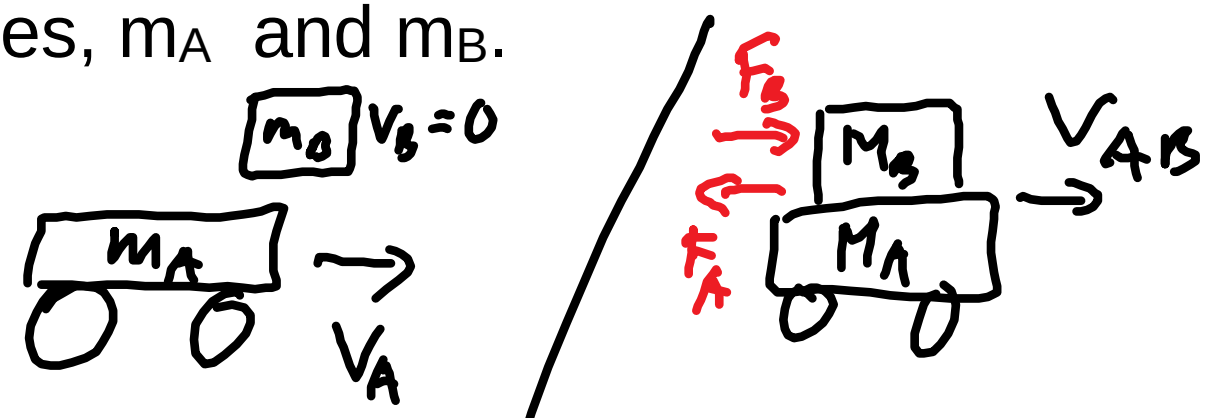
Law of Conservation of Momentum

Look at the collision between two masses, m_A and m_B.



By Newton's third Law

$$F_B = -F_A$$

$$\text{Impulse} = \Delta p = F_{net}\,\Delta t$$

$$F = \frac{\Delta p}{\Delta t}$$

$$\Delta P_A = -\Delta P_B$$

$$\frac{\Delta p}{\Delta t} = \frac{\Delta p}{\Delta t}$$

$$\Delta p_A = -\Delta p_B$$

$$p_{fA} - p_{iA} = -(p_{fB} - p_{iB})$$

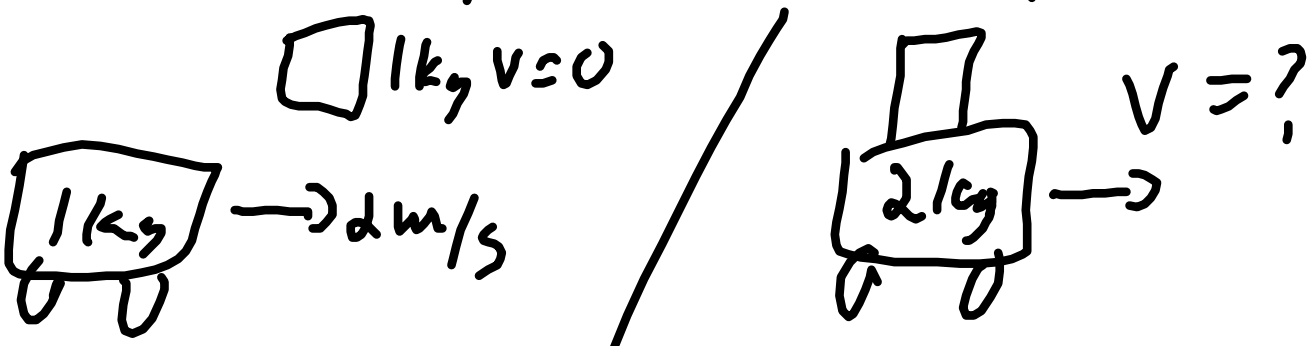
$$p_{fA} - p_{iA} = -p_{fB} + p_{iB}$$

$$p_{fA} + p_{fB} = p_{iA} + p_{iB}$$

$$\begin{matrix}\text{total momentum} \\ \text{Before}\end{matrix} = \begin{matrix}\text{total momentum} \\ \text{After}\end{matrix}$$

Assuming: No External forces
- No outside pushes, friction, slopes

- A closed, isolated system.



$$p_{Ai} + p_{Bi} = p_{Af} + p_{Bf}$$

$$m_A v_A + m_B v_B = (m_A + m_B) v_{AB}$$

$$(1.0\,kg)(2\,m/s) + (1.0\,kg)(0) = (1.0\,kg + 1.0\,kg) v_{AB}$$

$$2\,m/s + 0 = 2.0\,v_{AB}$$

$$\boxed{v_{AB} = 1.0\,m/s}$$

eg. a 2.0 kg cart moving at 2.0m/s hits a 1.0 kg cart moving at -3.0m/s.

a) what is the momentum of each cart

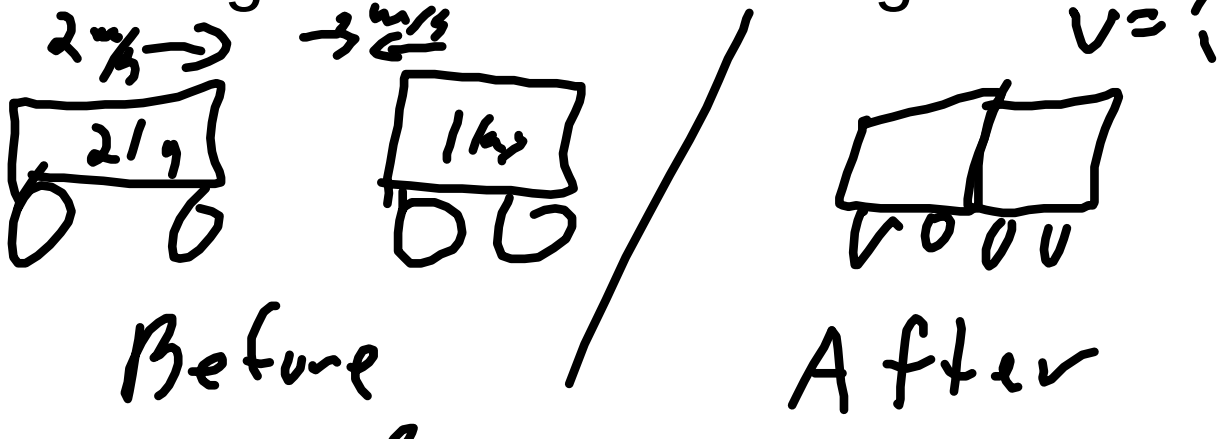
before the collision?

b) if the carts stick together, what is their velocity after the collision?

c) if the 2.0 kg cart bounces back instead of sticking at -0.20m/s, what is the velocity of the 1.0 kg cart after the collision?

d) if the collisions happen over 0.20s, what is the force between the carts in b and c?

a) p=mv = 2.0kg x 2.0m/s= 4.0 kgm/s
p = 1.0kg x -3.0 m/s = -3.0 kgm/s



$p_A + p_B = (m_A + m_B) V_{AB}$

$4\ kgm/s + -3kgm/s = (2kg + 1kg) V_{AB}$

$$V_{AB} = +\frac{1}{3}\ m/s$$

$$\boxed{V_{AB} = +0.33\ m/s}$$

c)

$$P_{Ai} + P_{Bi} = P_{Af} + P_{Bf}$$

$$4\ kgm/s - 3 = m_a V + M_B V$$

$$1\ kgm/s = 2kg^{(-0.2)}\ m/s + 1\ kg\ V$$

$$1\ kgm/s + 0.4\ kgm/s = 1\ kg\ V$$

$$\boxed{V = 1.4\ m/s}$$

d)

$$F = \frac{\Delta P}{\Delta t} = \frac{P_f - P_i}{\Delta t}$$

6 - A $2\,kg$ $v_i = 2\,m/s$ $v_f = 0.37\,m/s$

$$\frac{\Delta p}{\Delta t} = \frac{2\,kg(0.33\,m/s) - 2\,kg(2\,m/s)}{0.20\,s}$$

$$= \boxed{-17\,N}$$

c) $$\frac{\Delta p}{\Delta t} = \frac{2\,kg(-0.20\,m/s) - 2\,kg(2\,m/s)}{0.20\,s}$$

$$= \boxed{-22\,N}$$